TADPOLE Competition: Prediction of Alzheimer’s Evolution using Statistical Models and Machine Learning

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Introduction

Progression of Neurodegenerative Diseases (POND)

- UCL Centre for Inverse Problems
- Translational Imaging Group (TIG)
- Centre for Medical Image Computing (CMIC)
- Surgical Robot Vision Research Group
- Ultrasound guided interventions
- Radiotherapy group
- Breast Imaging Group
POND Aim: Develop Computational Models for Disease Progression

- **Event-Based Model**  
  (Fontejin et al., Neuroimage, 2012)
  
  - Event 1
  - Event 2
  - Event 3
  - Event 4

- **Differential Equation Model**  
  (Oxtoby et al., submitted, 2017)
  
  - $y$ vs $x$ graph
  - $\hat{x}(t)^{10}$ vs $t$ (years)

- **Gaussian-Process Regression**  
  (Lorenzi et al., IPMI, 2015)
  
  - Brain images with color scale
  - AD (2yrs), HC (2yrs), MCIc (2yrs), MCIc (3yrs), MCIc (4yrs)

- **Subtype and Stage Inference**  
  (Young et al., submitted, 2017)
  
  - SUBTYPES
  - TIME
POND Aim 2: Apply the Models to Distinct Neurodegenerative Diseases

**typical AD**
(Young et al., submitted, 2017)

Stage 1 | Stage 5 | Stage 9 | Stage 13 | Stage 17

**Familial AD**
(Oxtoby et al., submitted, 2017)

**Multiple sclerosis**
(Eshaghi et al., Brain, 2017)

**Huntington’s disease**
(Wijeratne et al., in preparation)
Alzheimer’s Disease is a Devastating Disease

- 46 million people affected worldwide

![Map showing dementia prevalence worldwide]
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No treatments available that stop or slow down cognitive decline

Q: Why did clinical trials fail? A: Treatments were not administered early enough
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Q: How can we then identify subjects early in order to administer treatments?
A: Biomarkers ...
Biomarker Evolution creates a Unique Disease Signature that can be used for Staging Individuals in Clinical Trials

- Accurate disease staging → better patient stratification
- Problem: This is a "hypothetical" (i.e. qualitative) disease progression model
- Why construct a quantitative model?
Benefits of Quantitative Disease Progression Models

- Basic biological insight

![Diagram showing disease progression with biomarker on y-axis and disease stage on x-axis]
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- Staging can help stratification in clinical trials
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Need to identify which models and features are best at above tasks ...
TADPOLE Challenge aims to identify algorithms that best predict future evolution of subjects at-risk of AD

TADPOLE Challenge: Prediction of Longitudinal Evolution in Alzheimer’s Disease
What to do

**Input:** Large dataset from ADNI:
- $>1,667$ subjects with a total of $12,000$ visits.
- $>2,000$ biomarkers from imaging, demographic, cognitive and genetic data

**Task:** Estimate the progression over the next 5 years of three key biomarkers:
- Diagnosis
- ADAS-COG13
- Ventricle Volume
Evaluation

**Overall winner**: lowest sum of ranks in the three categories above

- Diagnosis MAUC
- ADAS-COG13 MAE
- Ventricle Volume MAE

We will offer prizes!

**Live leaderboard** will show progress of each team this week:

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Join the TADPOLE Challenge!

- URL: https://tadpole.grand-challenge.org/
- Prize fund: £30,000

Welcome to The Alzheimer’s Disease Prediction Of Longitudinal Evolution (TADPOLE) challenge.

Brought to you by the EuroPOND consortium in collaboration with the Alzheimer’s Disease Neuroimaging Initiative (ADNI).